

SHORT COMMUNICATION

***Hydrocotyle spinulifera* and *H. dimorphocarpa* (Araliaceae), two new Western Australian species with dimorphic mericarps**

Two new species of *Hydrocotyle* L. from the Moora–Geraldton–Paynes Find area of Western Australia are described and illustrated herein. Both species differ from all other members of the genus in having highly asymmetric fruits with one mericarp markedly winged and the other wingless. Their close relationship with the rare Western Australian species *H. muriculata* Turcz. is discussed. Both species have conservation priority.

Hydrocotyle spinulifera A.J.Perkins, *sp. nov.*

Type: Marchagee Nature Reserve, Western Australia [precise locality withheld for conservation reasons], 7 October 1997, B.P. Richardson BPR 0022 (*holo:* PERTH 04968751; *iso:* AD, CANB, MEL, NSW).

Hydrocotyle coorowensis H.Eichler ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 13 September 2017].

Hydrocotyle sp. *Coorowensis* (P.G. Wilson 12580), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 13 September 2017].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 1–4 cm high, 2–10 cm wide. *Stems* decumbent to ascending, pale green to reddish green, terete, glabrous. *Stipules* white, lanceolate to linear-lanceolate, 1.0–4.0 mm long, 0.5–2.5 mm wide, membranous, translucent, irregularly fringed to ciliate along margins. *Petioles* 10–40 mm long, glabrous or occasionally with a skirt of wiry white hairs at the base of the leaf lamina. *Leaf blades* simple, dorsiventral, carnos, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves, 4–20 mm long, 4–28 mm wide; adaxial surface uniformly green or pale reddish green, glabrous; abaxial surface pale green, glabrous (or rarely with a few scattered, simple, antrorse hairs). *Leaf margins* toothed; teeth obtuse to acute. *Median leaf lobes* ovate to obovate, 4–16 mm long, 2–11 mm wide, with 1–6 marginal teeth. *Lateral leaf lobes* 3–17 mm long, 3–16 mm wide, with 3–9 marginal teeth, incised into two asymmetrical lobules in pedate leaves; leaf sinuses 10–70% of lateral lobe length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 12–30-flowered, 5–8 mm wide, the first umbel to flower and fruit borne centrally on a peduncle distinctly shorter than rosette leaves, with successive umbels borne along stems radiating out from the basal rosette. *Peduncles* terete, shorter than subtending leaves, 1–12 mm long, glabrous. *Involucral bracts* absent. *Pedicels* light green, subterete, somewhat flattened, recurved in outermost flowers, erect in innermost flowers, 1–2 mm long, arranged in three whorls; outermost ones basally connate (joined to neighbouring pedicels by a membranous flap of tissue), with 1–3 wiry pendulous hairs (predominantly simple, rarely bifid) near attachment to the peduncle. *Flowers* all hermaphrodite, protandrous. *Sepals* 5, filiform, setose, 0.6–0.8 mm long. *Petals* 5, predominantly cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.5–0.7 mm long, 0.3–0.4 mm wide. *Filaments* white, 0.6–1.0 mm long. *Anthers* light cream, 0.2–0.3 mm long. *Ovaries* pale green

at anthesis, bilaterally flattened, orbicular, minutely spinose along dorsal ribs. *Fruiting pedicels* erect to incurved, 1.0–4.0 mm long, with outermost ones distinctly longer than inner ones. *Schizocarps* bilaterally flattened, bearing dimorphic mericarps; mericarps light green turning light creamy brown on outer (flattened) margins and light orange-brown (centrally) at maturity; commissure 90% the length of inner mericarp and 30–40% of the outer mericarp. *Outer mericarps* markedly winged (between the dorsal and lateral ribs), 2.0–2.7 mm long, 1.5–2.0 mm wide; dorsal rib distinctly spinulose (4–12 small spines) along margins, spines 0.05–0.40 mm long; lateral ribs prominently raised; outer surface of (raised) lateral ribs convex, papillate, minutely colliculate; surface between (raised) lateral ribs and median ribs deeply concave, with 3–5 prominently raised ridges running perpendicular to the commissure, occasionally papillate, minutely colliculate. *Inner mericarps* 0.9–1.2 mm long, 0.9–1.1 mm wide, morphologically similar to outer mericarps except for the lack of a wing. *Carpophores* persistent, acerose, 0.7–1.0 mm long. *Fruiting styles* swollen at the base, 0.9–1.1 mm long, reflexed. *Cotyledons* narrowly elliptic to oblong in the seedlings. (Figure 1A–C)

Diagnostic features. *Hydrocotyle spinulifera* can be distinguished from all other taxa in *Hydrocotyle* by following combination of characters: annual herbs with the first umbel to flower and fruit borne (centrally) amongst the leaves of the basal rosette on a peduncle distinctly shorter than rosette leaves; pedicels subterete (somewhat flattened), outermost pedicels basally connate (joined by a membranous flap of tissue); sepals filiform, setose; ovaries and mature mericarps spinose along dorsal ribs; mature schizocarps bearing dimorphic mericarps in which the outer mericarp is distinctly winged and the other wingless; carpophores persistent, acerose.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 7 Oct. 2009, *W. Chow* BENT 34 Q 1 58 (PERTH); 23 Nov. 2003, *A. Crawford* 469 (PERTH); 11 Sep. 1985, *Hj. Eichler* 23666 (CANB); 11 Sep. 1985, *Hj. Eichler* 23669 (CANB); 11 Sep. 1985, *Hj. Eichler* 23674 (CANB); 12 Sep. 1985, *Hj. Eichler* 23683 (CANB); 14 Sep. 1991, *E.A. Griffin* 6554 (PERTH); 20 Sep. 2000, *S. Hamilton-Brown* RG 34 (PERTH); 20 Sep. 2000, *S. Hamilton-Brown s.n.* (PERTH 06454895); 25 Sep. 2001, *S. Hamilton-Brown s.n.* (PERTH 06454771); 11 Aug. 1999, *G.J. Keighery & N. Gibson* 4911 (PERTH); 21 Sep. 1999, *M.N. Lyons & S.D. Lyons* 4112 (PERTH); 26 Sep. 1999, *M.N. Lyons & S.D. Lyons* 4889 (PERTH); 16 Sep. 2000, *M.N. Lyons & S.D. Lyons* 4589 (PERTH); 17 Sep. 2000, *M.N. Lyons & S.D. Lyons* 4715 (PERTH); 5 Oct. 2000, *M.N. Lyons & S.D. Lyons* 4727 (PERTH); 20 Oct. 2000, *M.N. Lyons & S.D. Lyons* 4888 (PERTH); 15 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH 08029229, SYD); 8 Oct. 2017, *A.J. Perkins* AJP-WA 138 (PERTH); 27 Oct. 2017, *A.J. Perkins* AJP-WA 145 (PERTH); 24 Oct. 1983, *P.S. Short* 2200 (CANB, MEL); 22 Sep. 1987, *P.G. Wilson* 12580 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from August to November.

Distribution and habitat. Extends from near Moora north to Three Springs and further north-east to beyond Morawa (Figure 2). Plants grow along moist margins of seasonal wetlands, freshwater and saline lakes in this region, often sheltered under small shrubs of *Tecticornia* and *Frankenia* spp. and in association with *Casuarina obesa* or *Melaleuca* spp. (Figure 1D).

Conservation status. *Hydrocotyle spinulifera* is listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. *Coorowensis* (P.G. Wilson 12580). *Hydrocotyle spinulifera* is known from 13 general localities scattered over a distance of c. 175 km, including several nature reserves.

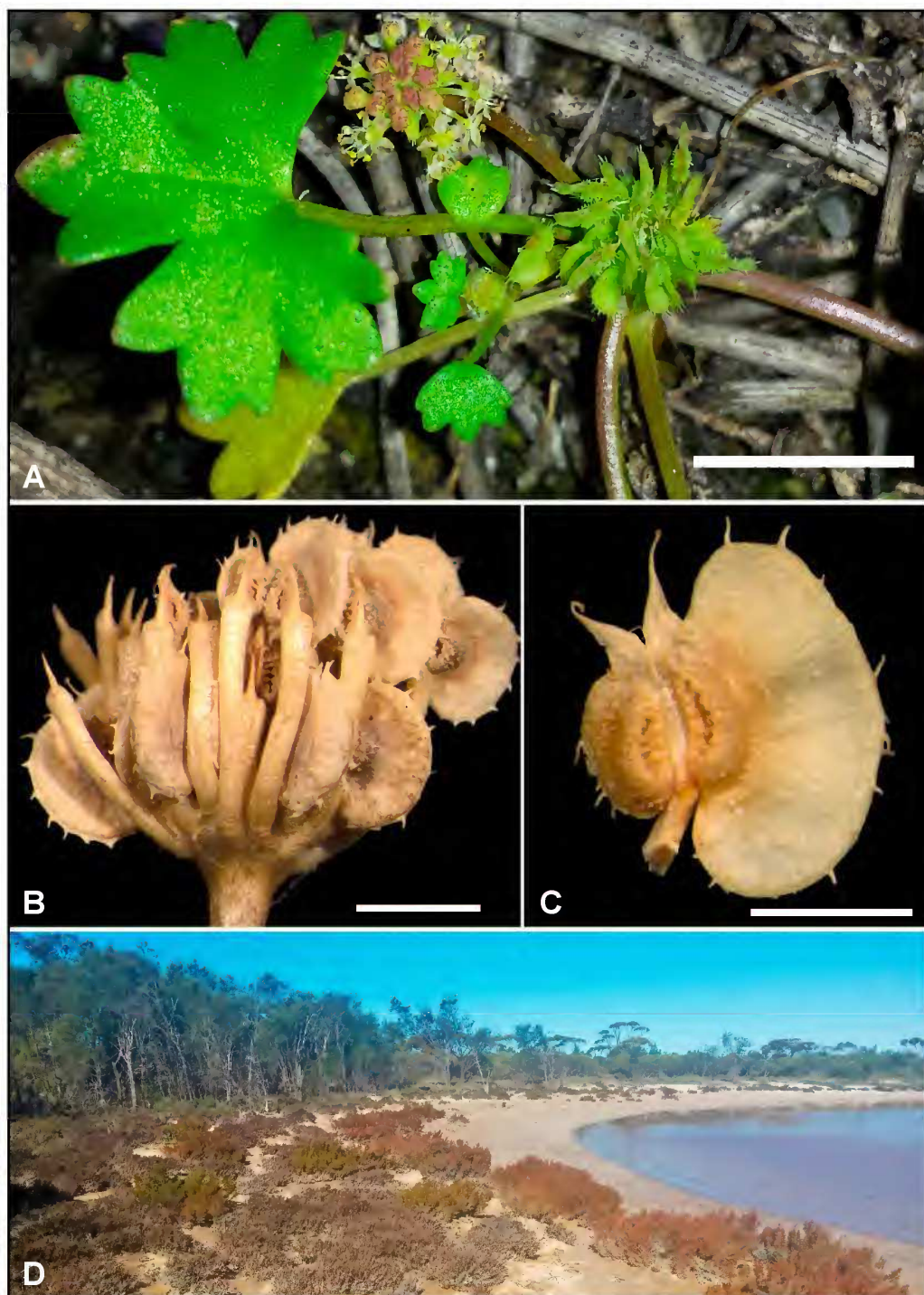


Figure 1. *Hydrocotyle spinulifera*. A – flowering plant *in situ* showing an umbel with spinose fruit; B – fruiting umbel showing pedicels with persistent acerose carpophores; C – lateral view of schizocarp showing dimorphic mericarps with small spinose dorsal ribs; D – typical habitat. Scale bars = 10 mm (A); 2 mm (B, C). Voucher: A.J. Perkins AJP-WA 138 (A); A. Crawford 469 (B, C). Photographs by A. Perkins.

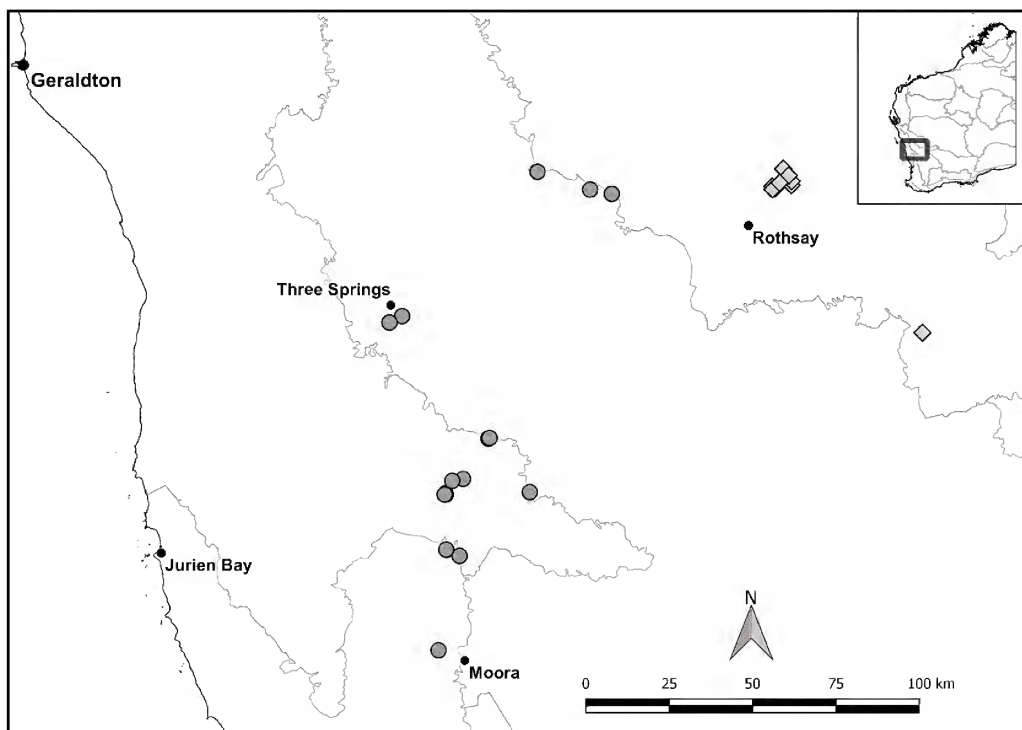


Figure 2. Distribution of *Hydrocotyle spinulifera* (●) and *H. dimorphocarpa* (◆) based on specimens held at PERTH and CANB. Map shows Interim Biogeographic Regionalisation for Australia version 7 bioregions (Department of the Environment 2013) in grey. Overview map for Western Australia shown in the top right corner.

Etymology. The epithet is derived from the Latin words *spinula*, ‘a small spine’, and *fero*, ‘to bear’, in reference to the small spines borne along the dorsal ribs of the mericarps (Figure 1A–C). The common name of ‘Spiny Fruited Pennywort’ is here suggested.

Affinities. *Hydrocotyle spinulifera* is morphologically similar to the rare Western Australian annuals *H. muriculata* (Figure 3C) and *H. dimorphocarpa* A.J.Perkins. All three species possess a subsessile umbel borne (centrally) amongst the leaves of the basal rosette as the first umbel to flower and fruit, schizocarps with at least one winged mericarp, and persistent carpophores.

Hydrocotyle spinulifera differs from *H. muriculata* by having glabrous stems and peduncles (hairy stems and peduncles in *H. muriculata*; Figure 3A), leaf lamina margins glabrous (small, acute hairs scattered along lamina margins, often on marginal teeth in *H. muriculata*), bases of fruiting pedicels connate (free in *H. muriculata*), mericarps dimorphic (both mericarps winged in *H. muriculata*; Figure 3B), mericarps with spinose dorsal ribs (glabrous dorsal ribs in *H. muriculata*), sepals setose (calyx absent in *H. muriculata*), and fruiting styles (see Figure 1C) distinctly swollen at base (see Figure 3B for styles of *H. muriculata*).

Additionally, *H. spinulifera* and *H. dimorphocarpa* both possess fruit with dimorphic mericarps, setose sepals, and connate pedicels (joined at the base by a membranous flap of tissue). *Hydrocotyle spinulifera* differs by having linear pedicels (flattened pedicels distinctly broader at their base than apex in *H. dimorphocarpa*), mericarps with spinose dorsal ribs (glabrous in *H. dimorphocarpa*), and

simple hairs on pedicel bases of the outermost whorl (multifid hairs with 2–12 wiry hair tips branching from a broad base in *H. dimorphocarpa*).

Hydrocotyle dimorphocarpa A.J.Perkins, *sp. nov.*

Type: north-north-east of Rothsay, Western Australia [precise locality withheld for conservation reasons], 24 September 2011, R. Meissner & R. Coppen 4723 (*holo*: PERTH 08433771; *iso*: CANB, NSW).

Hydrocotyle sp. Warriedar (P.G. Wilson 12267), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 13 September 2017].

Annual herbs consisting of a basal rosette of leaves and branches bearing leaves and umbellate inflorescences, 1–5 cm high, 2.5–20 cm wide. *Stems* decumbent, terete, glabrous, pale green to reddish green. *Stipules* white, lanceolate to ovate, 2.5–4.5 mm long, 1.5–3.0 mm wide, membranous, translucent, irregularly fringed to ciliate along margins. *Petioles* crimson to reddish green, 9–40 mm long, glabrous or with scattered wiry hairs (along the upper half) becoming most dense towards the base of the leaf lamina. *Leaf blades* simple, dorsiventral, discolorous, carnose, broadly ovate and trilobed or shallowly palmatifid in juvenile leaves, trilobed to pedately lobed in mature leaves, 6–21 mm long, 6–30 mm wide; adaxial surface uniformly green or occasionally reddish green, glabrous; abaxial surface dark crimson to reddish green, glabrous (particularly in juvenile leaves) or occasionally with scattered, simple, antrorse hairs (in mature pedate leaves). *Leaf margins* toothed, teeth obtuse to acute, sometimes tipped with short acute hairs. *Median leaf lobes* ovate to obovate, 5–16 mm long, 3–11 mm wide, margins with 1–3 teeth. *Lateral leaf lobes* 5–16 mm long, 4–16 mm wide, 2–8 marginal teeth, incised into two asymmetrical lobules in pedate leaves; leaf sinuses 10–60% of lateral lobe length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 18–36-flowered, 4–12 mm wide, the first umbel to flower and fruit borne centrally on a peduncle distinctly shorter than rosette leaves, with successive umbels borne along stems radiating out from the basal rosette. *Peduncles* terete, shorter than subtending leaves, 1–34 mm long, glabrous. *Involucral bracts* absent. *Pedicels* white to cream, distinctly dorsiventrally flattened, recurved in outermost flowers, erect in innermost flowers, 0.5–2.0 mm long, arranged in three whorls; outermost ones basally connate (joined to neighbouring pedicels by a membranous flap of tissue), with 1 appressed, multifid hair (2–12 wiry acropetal hair tips branching from a broad base). *Flowers* all hermaphrodite, protandrous. *Sepals* 5, filiform, setose, 0.7–0.8 mm long. *Petals* 5, predominantly cream with pale pink to crimson on the dorsal surface (towards the apex), ovate, 0.5–0.8 mm long, 0.3–0.5 mm wide. *Filaments* white, 0.7–0.9 mm long. *Anthers* light yellow, 0.2–0.3 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, glabrous along dorsal ribs. *Fruiting pedicels* incurved at maturity, 1.0–6.5 mm long, 0.5–1.5 mm wide at base (narrower at apex), outermost ones distinctly longer and wider than inner two whorls. *Schizocarps* bilaterally flattened, bearing dimorphic mericarps; *mericarps* light green turning light creamy brown on outer (flattened) margins and reddish brown (centrally) at maturity; commissure 70–80% the length of inner mericarps and 30–50% of the winged outer mericarp. *Outer mericarps* markedly winged (between the dorsal and lateral ribs), 1.6–2.7 mm long, 1.0–2.0 mm wide; wing cordate, glabrous; dorsal ribs prominent, glabrous along margins; lateral ribs prominently raised; outer surface of (raised) lateral ribs convex, papillate, minutely colliculate; surface between (raised) lateral ribs and median ribs deeply concave, papillate, minutely colliculate. *Inner mericarps* orbicular, 1.0–1.2 mm long, 0.7–1.0 mm wide, morphologically similar to outer mericarps except for the lack of a wing. *Carpophores* persistent, acerose, 0.4–0.6 mm long. *Fruiting styles* swollen at the base, 0.8–1.0 mm long, reflexed. *Cotyledons* narrowly elliptic to oblong in the seedlings. (Figure 4A–C)

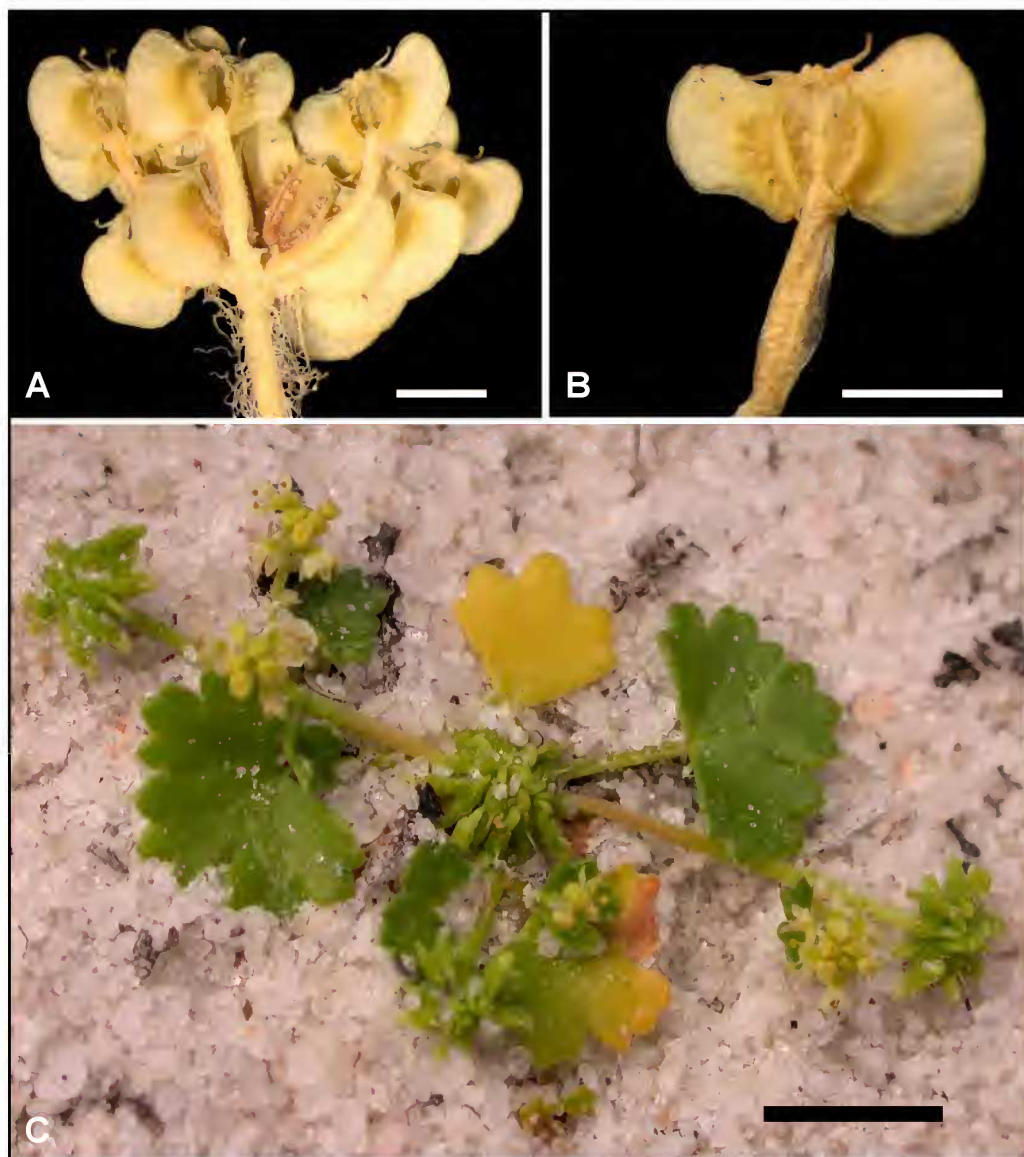


Figure 3. *Hydrocotyle muriculata*. A – fruiting umbel subtended by a hairy peduncle; B – schizocarp showing both mericarps with wings; C – flowering plant *in situ* showing the primary umbel (at the centre of the plant) with developing fruit. Scale bars = 2 mm (A, B); 10 mm (C). Voucher: HJ. Eichler 23103 (A, B); A.J. Perkins s.n. (PERTH 08012741) (C). Photographs by A. Perkins.

Diagnostic features. *Hydrocotyle dimorphocarpa* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: annual herbs with the first umbel to flower and fruit borne centrally amongst the basal rosette on a peduncle (1–7 mm long) distinctly shorter than rosette leaves; fruiting pedicels distinctly dorsiventrally flattened with the base distinctly broader than the apex, arranged in three whorls, connate at their base with outermost whorl of pedicels additionally being joined to neighbouring pedicels by a membranous flap of tissue, at the base of each (outer whorl) pedicel is an appressed multifid hair (3–12 wiry acropetal hair tips branching from a broad base); sepals filiform, setose; ovaries and mature mericarps glabrous along dorsal ribs; mature schizocarps with outer mericarp distinctly winged and the other wingless; carpophores persistent, acerose.

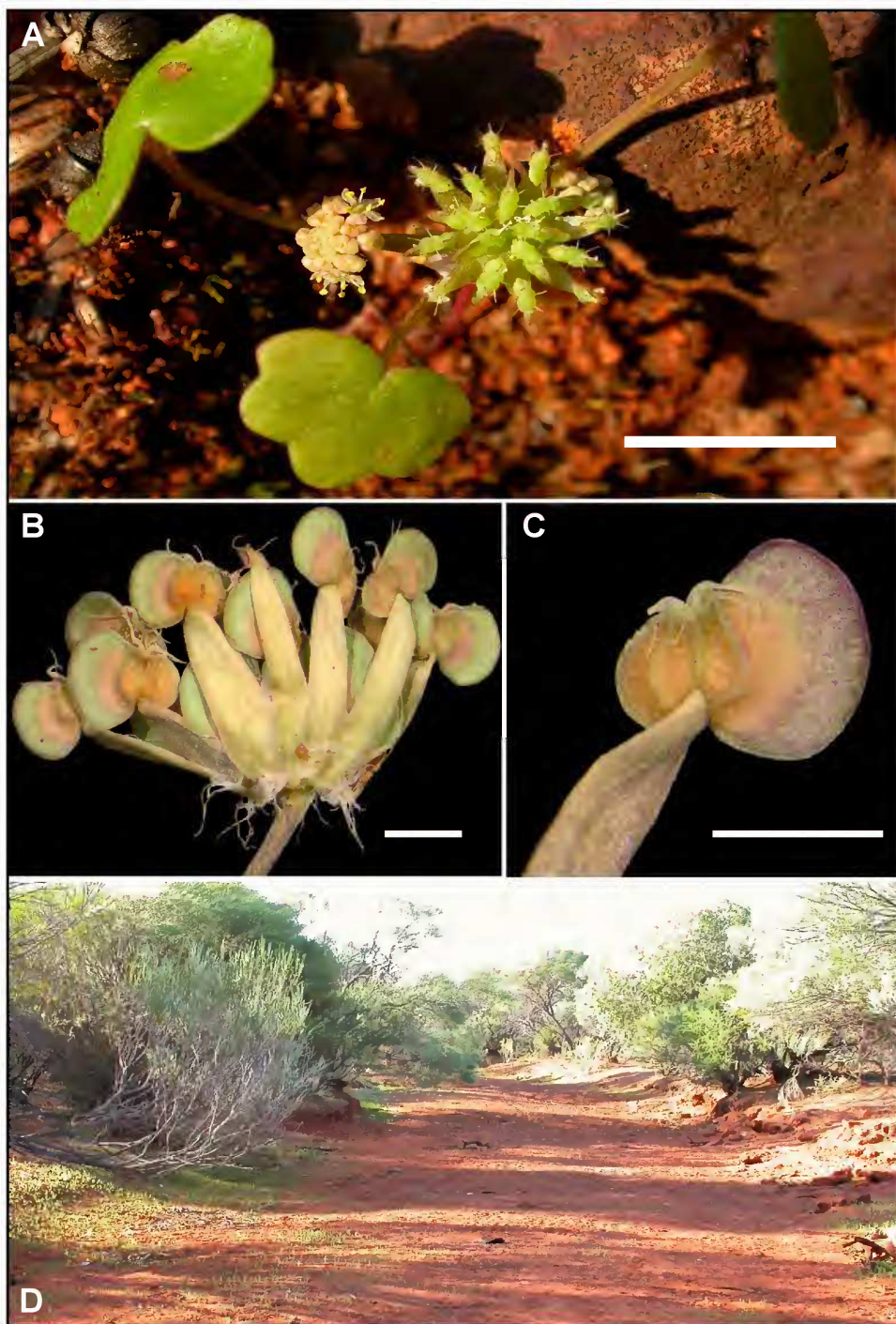


Figure 4. *Hydrocotyle dimorphocarpa*. A – plant *in situ* showing an umbel with developing fruit and setose sepals, and a subsequent umbel in flower; B – fruiting umbel showing flattened pedicels with multifid hairs at the base; C – schizocarp with dimorphic mericarps; D – typical habitat. Scale bars = 10 mm (A); 2 mm (B, C). Voucher: A.J. Perkins s.n. (PERTH 08048444) (A); R. Meissner & R. Coppen 4723 (B, C). Photographs by A. Perkins.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 Sep. 2003, *D. Coultas s.n.* (PERTH 07343817); 27 Sep. 2004, *C. Godden & G. Woodman* Hsw Loc 1 (PERTH); 29 Sep. 2004, *C. Godden & G. Woodman* Hsw Loc 28 (PERTH); 24 Sep. 2011, *R. Meissner & R. Coppen* 4722 (PERTH); 25 Sep. 2011, *R. Meissner & R. Coppen* 4721 (PERTH); 26 Sep. 2011, *R. Meissner & R. Coppen* 4719 (PERTH); 26 Sep. 2011, *R. Meissner & R. Coppen* 4720 (PERTH); 28 Sep. 1998, *C.J. Nicholson* 37 (PERTH); 4 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08048444, SYD); 26 Sep. 1986, *P.G. Wilson* 12267 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to October.

Distribution and habitat. *Hydrocotyle dimorphocarpa* is only known from two general localities within the Yalgoo bioregion (Figure 2), one near Mt Gibson and the other within ex Warriedar Station, north-east of Rothsay. Plants grow in open woodland and mallee along creekbanks or drainage lines containing red-brown clay loam soils (Figure 4D).

Conservation status. *Hydrocotyle dimorphocarpa* is listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Warriedar (P.G. Wilson 12267). The two known areas of occurrence of this species are over 100 km apart.

Etymology. The epithet is derived from the Greek *dimorphos*, ‘two-shaped’, and *carpos*, ‘fruit’, in reference to the mature schizocarps having dimorphic mericarps (Figure 4B, C), with one mericarp being winged and the other lacking a wing. The common name of ‘Single-winged Pennywort’ is here suggested.

Affinities. *Hydrocotyle dimorphocarpa* is morphologically similar to the rare Western Australian annuals *H. muriculata* and *H. spinulifera*. All three species possess a shortly pedunculate umbel borne centrally amongst the leaves of the basal rosette as the first umbel to flower and fruit, schizocarps with at least one winged mericarp and persistent carpophores. *Hydrocotyle dimorphocarpa* differs from both *H. muriculata* and *H. spinulifera* by having fruiting pedicels distinctly dorsiventrally flattened with the base distinctly broader than the apex (pedicels linear in *H. muriculata* and *H. spinulifera*), and outermost pedicels with an appressed multifid hair consisting of 3–12 acropetal hair tips branching from a broad base (simple or rarely bifid hairs on pedicels in *H. spinulifera* and glabrous pedicels *H. muriculata*).

Hydrocotyle dimorphocarpa is closely allied to *H. spinulifera* (thus differing from *H. muriculata*) as both taxa possess fruit with dimorphic mericarps, setose sepals, connate pedicels (joined at the base by a membranous flap of tissue) and glabrous peduncles. *Hydrocotyle dimorphocarpa* can be further distinguished from *H. spinulifera* by the fruit being glabrous along the dorsal ribs (spinose along the dorsal ribs in *H. spinulifera*) (Figures 1, 4).

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References

- Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. <http://www.environment.gov.au/land/nrs/science/ibra#ibra> [accessed 13 September 2017].
- Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants> [accessed 1 February 2018].

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